gealing probably is to bind the molecules into a rigid mass quite irrespective of any special polar attractions which they may have for each other. They are bound together by the general cohesive force, and their freedom of movement is much curtailed. This is evident not only because they cannot move sufficiently freely to take up the regularly oriented arrangement, but

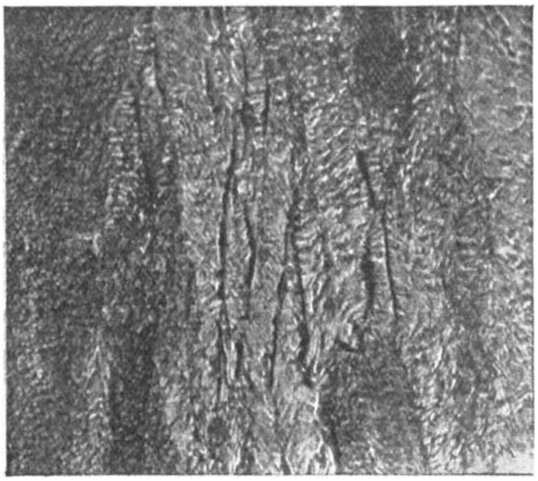

FIG. 1.—Hard-drawn gold wire. Magnification ×700.

also because their elasticity in this state is much less perfect than it is in the crystallised state; the molecules cannot vibrate freely in the amorphous state.

The effect of raising the temperature to the crystallising point is to raise the kinetic energy of the molecules, and therefore to neutralise a part of the cohesive force, thus weakening it and enabling the

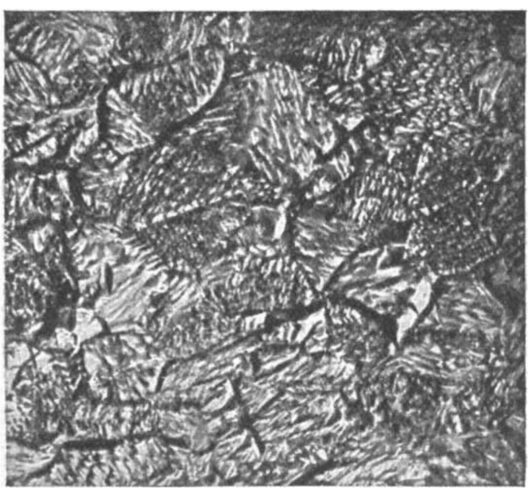

FIG. 2.—Hard-drawn gold wire after crystallisation at 280°. Magnification ×700.

molecules to spring into their uniformly oriented position; the crystalline state is thus restored and the internal energy of the mass is reduced. The present observations show that crystallisation occurs over a short and definite range of temperature—short, that is to say, compared with the ranges above and below the crystallisation range. Below the crystallisation range the amorphous or non-crystalline form of the metal is known by direct observations to be perfectly stable down to −180°, while above that range the crystalline form is stable up to the temperature of liquefaction.

The changes in the electrical, mechanical, and other properties, which occur when the crystallisation range is reached, amply confirm the microscopic observations, and all point to the occurrence of an important change in the molecular structure.

By means of an acoustical method it has been found possible to detect the minute changes in elasticity which occur as the temperature is gradually raised to the crystallising range. In this way it has been made evident that there are two distinct stages in the relief of the molecular strains which are caused by hardening. In the first stage no important alteration in the other properties of the hardened metal occurs, while in the second and more important stage the complete restoration of elasticity exactly corresponds with the other changes which occur at the crystallisation temperature.

## OCTOBER METEORS.

OCTOBER is a month when meteors are decidedly numerous. They are particularly abundant from October 15 to October 25, and this period includes the well-known shower of Orionids, but the conditions will be unfavourable this year owing to the full moon of October 21.

Early in the month there is occasionally a rich shower near the northern boundary of Boötes at 230°+52°, and on October 8 there are many meteors from Aries about 42°+20°, from Auriga, 77°+32°, and from about this date to October 20 there is a well pronounced morning shower of long-pathed meteors from 154°+39°.

Before sunrise the observer will also trace radiants at 101°+1°, 100°+13°, 108°+13°, 121°+0°, 133°+68°, 133°+48°.

Thirty years ago, viz. in 1877, during the first week in October there were very well pronounced showers at 133°+79° and 313°+77°; the former gave swift streak-leaving meteors, the latter slow faint meteors.

October furnishes several radiants of Perseids, and one of the most notable of these agrees precisely in its apparent position with the centre of the great display of August Perseids on the date of maximum. Between October 8 and 14 I have recorded a number of slow meteors from a well defined radiant at 45°+58°.

The principal shower in the last half of October is one of Arietids from near $\epsilon$. On 1877 October 28–November 1, I saw thirty-one meteors from 43°+22°, and on 1887 October 11–24, forty-five meteors were registered from 40°+20°. The members of this system are white, rather slow, and occasionally brilliant, with trains of yellow sparks. As they were very active in 1877 and 1887, they may periodically recur at intervals of a decade, and be numerously manifested again in 1907.

W. F. DENNING.

## MR. HALDANE ON SCIENCE IN COMMERCE.

A VERBATIM report of the speech on scientific commercial education in relation to the successful pursuit of trade, delivered by Mr. Haldane at Liverpool on September 19, and briefly mentioned in last week's NATURE, appeared in the *Liverpool Daily Post* of September 20. The two main points developed by Mr. Haldane in the course of his remarks were the domination of mind over matter and the value of

organisation. Expressed briefly, brain-power was described as the chief factor upon which commercial progress must depend. Subjoined is a summary of the parts of the speech concerned with this subject:—

We live in a time when we shall fall behind in the race if we do not possess as a nation the gift of organisation. Capital has become the instrument in the hands of the directing brain; and the directing brain for huge concerns of to-day is only big enough if it can embrace in its survey the whole of the competing civilisation. Germany, France, the United States, and other countries are pressing us hard, and it is only by the possession of ideas, by the willingness to work as our forefathers never worked, with the same concentration, we can hope to hold our own in the race. At the bottom of great ideas comes great capacity to organise if they are to succeed; and with great capacity to organise great capacity to think. It is the thinker, the man of ideas, who can translate thought into action, that wins the race of to-day—a race far stiffer, far harder, far nobler, than the easy race of our forefathers. Our universities are growing; our tropical schools are starting; our organisation of commerce is going to be on a larger scale; and yet it is none too soon, because other nations are doing the very same thing. So it comes that the great lesson which this nation has to learn appears to be this—to recognise that mind dominates matter, that brains lie at the root of things, and that upon their working out and the results which brains have provided no progress can be made without that secondary but emphatically valuable faculty is added—the faculty of organisation.

The creation of the Committee of Imperial Defence carried scientific principles into the sphere of government, and was the first step toward getting military and naval notions into order. We now have a general staff which is a body, not to exercise command, but to give advice in a thoroughly practical fashion and in a fashion which can be enforced. The speculation may be indulged in whether one of the great reforms of government to which we are coming—because we have been driven to it—will not be the creation in an organised fashion of just such a general staff for departments of government, and not merely for the Army. A concrete instance may be given of the value of scientific advice. In two parts of the dominions of the Crown there are diseases of a terrible character raging at this moment. One is understood, because it has been dealt with by the scientific experts of the Government, but the other is not, because there are no scientific experts to deal with it. The first case is in India, where research work is carried out by experts whom the Indian Government has organised, and who are out working in the subordinate departments of the Government, exercising no authority, but giving advice and reporting to headquarters. These investigators and advisers have brought the plague in India within compass. Then, to give a second case, in one of the West Indian islands, possibly in more, there flourishes what is called tropical anæmia, which, although not fatal to life in the ordinary sense, reduces the working power of its victims by 30 per cent. or 40 per cent. This is a sheer loss to the State, and yet the disease can be and has been combated in other parts of the world. This disease, which also exists in our mines, where it is known as ankylostomiasis, was recently very familiar in Westphalia, and the German Government, working on general staff principles, dealt with the scourge on scientific principles from the beginning. The disease exists in our Cornish mines, but we have not extirpated it as thoroughly as the Germans have.

If people were but aware what can be accomplished and what can be saved to the State, and the extent to which our community can be made more efficient by dealing with these things on a scientific footing, the nation would be wiser and better. This may seem to be the bureaucratic point of view, but when it is founded on science it is the right point of view; and the governments of the future will find more and more work of this kind forced upon them.

## THE REV. DR. JOHN KERR, F.R.S.

JOHN KERR, the discoverer of the Kerr effect in magneto-optics, was born at Ardrossan, Ayrshire, December 17, 1824, and received part of his early education at a parish school in Syke. He graduated M.A. with honours in 1849 at Glasgow University, where he greatly distinguished himself, especially in mathematics and natural philosophy. He completed the usual course in theology at the Free Church College in Glasgow, but, instead of entering on a clerical career, became in 1857 mathematical lecturer in the Free Church Normal Training College for Teachers in Glasgow, an institution which has recently passed under the direct control of the Scottish Education Department. Here for forty-four years he trained in mathematics and physics thousands of our youth who afterwards filled important scholastic positions. On his retirement in 1901 his old pupils entertained him at a banquet, when Prof. Magnus Maclean in their name presented him with a tea and coffee service, and made a graceful reference to his great work.

In 1867 Kerr brought out an "Elementary Treatise on Rational Mechanics" (Hamilton, Glasgow), which deserves more than a passing notice. While adhering to the usual mode of treatment at that time, namely, first statics and then dynamics, he introduced what was then a novelty in English books, a separate chapter on kinematics as a preliminary to the chapters on kinetics. Numerous examples are appended to the various chapters, and it is doubtful if among the many more modern treatises of similar standard a better working book for the student exists. Every here and there the physical mind of the author is in evidence, especially in an appendix or "Note," the object of which "is to give a sketch of some of the simpler facts connected with the manifestations of force in nature." Elasticity, cohesion, capillarity, electricity, magnetism, physical optics, and sound are briefly commented on; and the conservation of energy is discussed under that name. The book was written before the formal appearance of Thomson and Tait's "Natural Philosophy," but no doubt under its influence. It is interesting to note that Kerr returns to Newton for the true foundation of dynamics.

In 1875 Kerr published his first paper "On a New Relation between Electricity and Light: Dielectric Media Birefringent" (*Phil. Mag.*, vol. l., pp. 337–348 and 446–458). Accepting the Faraday theory of electric strain, he constructed a remarkably simple form of apparatus in which the ends of two terminals in connection with the open secondary circuit of an induction coil were brought to within a quarter of an inch of each other in the heart of a plate of glass. Nicol prisms were arranged for extinction with their principal axes at angles of 45° with the line of terminals. When the induction coil was set in operation light was restored by the birefringent action of the electrified glass. The investigation was soon extended to liquids, such as bisulphide of carbon, benzol, paraffin, &c. By an extremely neat and simple use of a compensator of mechanically strained glass inserted in the path of the polarised ray, he proved that electrified glass acted upon transmitted light like a negative uniaxal crystal with its axis parallel to the lines of electric force. Quartz acted like glass, but resin acted like a positive uniaxal, as if it were extended along the lines of force. In later papers, published at intervals in the *Philosophical Magazine* between 1879 and 1882, he continued this research with more elaborate apparatus, and extended it to a great many substances, establishing, among other